

(21) Application No 8039377  
(22) Date of filing 9 Dec 1980  
(30) Priority data  
(31) 7930202  
(32) 10 Dec 1979  
(33) France (FR)  
(43) Application published  
8 Jul 1981  
(51) INT CL<sup>3</sup>  
A61K 9/36  
(52) Domestic classification  
A5B 800 802 806 807 828  
834 G N  
(56) Documents cited  
None  
(58) Field of search  
A5B  
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(54) Delayed-release tablets for  
disintegration in the colon

(57) Delayed-release pharmaceutical  
tablets for disintegration in the colon  
comprise a compressed tablet core  
containing a pharmaceutically active  
agent, the said core being coated  
successively with: a) a first coating  
layer comprising a film-forming agent  
(e.g. ethyl cellulose) which does not  
deteriorate in neutral or alkaline  
medium, together with microcrystalline  
cellulose, and b) a second coating layer  
comprising an enteric coating agent.

## SPECIFICATION

**Compressed tablets for disintegration in the colon**

5 This invention relates to new compressed tablets adapted for disintegration in the colon, as well as to a process for preparing them.

By compressed tablets adapted for disintegration in the colon is meant herein compressed tablets of  
10 which the centre containing the active principle disintegrates substantially specifically in the colon.

In French Patent Specification No. 1,591,602 are described pharmaceutical dosage forms for oral administration, in which the active principle remains  
15 substantially protected from the digestive juices of the stomach and of the small intestine, whereby practically all the active ingredient is released in the colon. In these pharmaceutical forms the active principle is finely divided and surrounded with a resin.

20 These forms, however, possess a number of disadvantages. The duration of the gastro-intestinal transit varies considerably from one individual to another and according to the size of meals it can range from about twelve hours to more than  
25 twenty-four hours. Given that the dissolution of the resin covering the active principle is proportional to time, release of the latter in the colon is rather uncertain. In addition, it is difficult to coat the active principle homogeneously.

30 Attempts have, therefore, been made to find a technique other than simple dissolution which enables total specificity of release of the active principle at the level of the colon to be obtained.

It is known that the digestive tract of man is devoid  
35 of specific enzymes permitting the digestion of cellulose; however bacteria existing in the human colon have the ability to digest cellulose. We have found that this fact may be used to prepare compressed tablets which exhibit good specificity of  
40 release of the active principle in the colon by coating the active principal with a layer which includes microcrystalline cellulose.

Thus according to one feature of the present invention we provide compressed tablets adapted  
45 for disintegration in the colon comprising a centre containing the active principle, the said centre being covered successively:

- a) with a first coating layer comprised of a film-forming product which does not deteriorate in  
50 neutral or alkaline medium and of microcrystalline cellulose and
- b) with a second coating layer comprised of an enteric coating agent.

The microcrystalline cellulose may, for example,  
55 be that sold under the name of Rehocel (Rettenmaier), Avicel PH (American Viscose Division), Avicel RC (Lehmann and Voss) or Lintenspuver LH 330 (Rettenmaier).

The enteric coating agent may, for example, be  
60 cellulose acetylphthalate, hydroxypropylmethyl-cellulose phthalate, benzophenyl salicylate, cellulose acetosuccinate or copolymers of styrene and of maleic acid. Particularly preferred as enteric coating agent is cellulose acetylphthalate.

65 Among the film-forming products which do not

deteriorate in neutral or alkaline medium may preferably be considered ethyl cellulose.

In order to provide fine and solid coating films, the coating layers advantageously additionally contain  
70 one or more plasticisers. The plasticisers may for example, be selected from diethyl phthalate, dibutyl phthalate, propylene glycol and castor oil, the use of diethyl phthalate, dibutyl phthalate and/or propylene glycol being preferred.

75 Particular compressed tablets according to the invention which may be mentioned are those wherein the first coating has a mass of from 0.5% to 10% of that of the centre and the first coating contains from 30% to 80% by mass of microcrystalline  
80 cellulose.

Also preferred are compressed tablets wherein the enteric coating agent has a mass of from 2% to 10% of that of the centre.

According to a further feature of the present invention there is provided a process for preparing the  
85 new compressed tablets as defined above, which comprises coating centres containing the active principle by spraying thereon a solution of a film-forming product which does not deteriorate in  
90 neutral or alkaline medium and of microcrystalline cellulose in a solvent; drying the said coated centres; and then spraying a solution of an enteric coating agent in a solvent onto the dried coated centres and drying. If desired the solution of the  
95 film-forming product and cellulose and/or the solution of the enteric coating agent may additionally contain one or more plasticisers.

The film-forming agent and, if present the plasticiser(s) may be put into solution according to  
100 methods known *per se*, for example in methyl, ethyl or isopropyl alcohol, in acetone, ethyl acetate or ethylene chloride or in a mixture of these solvents. Coating can, for example, be carried out in a tumbler or by spraying onto the compressed tablets in suspension in air. The use of a tumbler is however preferred.

The compressed tablets, which form the subject of the present invention, confer a delay effect upon the active principle by localising its release to the colon.

110 These compressed tablets are thus of particular interest for giving medicaments where delayed release is desirable such as e.g. using barbiturates, amphetamine and aspirin. In addition, a colon-localised effect is also often sought, for example, in  
115 the treatment of certain parasitic complaints such as colic amoebiasis.

Particular medicinal active principles which may be mentioned for use in the compressed tablets of the present invention include, for example, those  
120 where a delayed release and/or a colon-localised release is desirable such as corticoids, anti-inflammatory agents, antibacterial agents and antibiotics.

It will be appreciated that the compressed tablets,  
125 of the present invention can if desired contain conventional adjuvants such as wetting agents, colouring agents or diluents, in the centres, and/or colouring agents or substances capable of protecting the active principle against the light, in the coatings.

130 The following non-limiting Examples serve to

illustrate the present invention.

*Example 1:*

*Preparation of neomycin compressed tablets.*

500 centres, each weighing 400 mg and containing 5 200 mg of neomycin sulphate, are introduced into a glass tumbler rotating at 30 revolutions/minute, and are sprayed for 40 minutes, under a pressure of 0.3 bar, at ambient temperature, with 22.5 ml of a solution of ethyl cellulose comprising:

- 10 - ethyl cellulose .....60 g
- dibutylphthalate .....25 g
- propylene glycol .....15 g
- isopropanol .....650 ml
- ethanol .....650 ml

15 with which was mixed microcrystalline cellulose (Avicel PH 101) .....1.25 g then left to dry for one night under vacuum. 500 coated centres each weighing on average 403 mg are thus obtained. These coated centres are then 20 sprayed, for one hour, under a pressure of 0.1 bar, at ambient temperature, with 320 ml of a solution comprising:

- cellulose acetylphthalate .....50 g
- 25 - diethylphthalate ..... 5 g
- isopropanol .....500 ml
- ethyl acetate .....500 ml

then left again for one night under vacuum. 500 30 coated compressed tablets are obtained, each weighing on average 428 mg.

*Example 2:*

*Preparation of prednisolone compressed tablets.*

500 centres each weighing 398 mg doses and con- 35 taining 5 mg of prednisolone are introduced into a glass tumbler, rotating at 40 revolutions/minute, and

are sprayed for 35 minutes, under a pressure of 0.2 bar, at ambient temperature, with 45 ml of a solution of ethyl cellulose comprising:

- 40 - ethyl cellulose .....60 g
- dibutylphthalate .....25 g
- propylene glycol .....15 g
- isopropanol .....650 ml

45 - ethanol .....650 ml with which was mixed microcrystalline cellulose (Avicel PH 101) ..... 5 g

and to which were added 45 ml of a mixture in equal parts of isopropanol and ethyl alcohol. Partial drying 50 is then carried out in fresh air, then the coated centres are left to dry for one night under vacuum. 500 coated centres are thus obtained, each weighing on average 411 mg. These coated centres are then sprayed for one and a half hours, at ambient temp- 55 erature, under a pressure of 0.1 bar, with constant drying in fresh air, with 320 ml of a solution comprising:

- cellulose acetylphthalate .....50 g
- 60 - diethylphthalate ..... 5 g
- isopropanol .....500 ml
- ethyl acetate .....500 ml

then left again to dry for one night under vacuum. 65 500 coated compressed tablets are obtained, each weighing on average 444 mg.

*Examples 3, 4, 5, 6, 7:*

*Preparation of barium sulphate compressed tablets.*

Work is carried out according to the method 70 described in Example 2. The centres each weigh on average 398 mg and contain 100 mg of barium sulphate.

	Examples				
	3	4	5	6	7
Ethyl cellulose solution	29.8ml	34.2ml	37.0ml	40.3ml	44.2ml
Microcrystalline cellulose	2.72 g	2.87 g	2.90 g	3 g	3 g
Isopropanol/ethanol mixture	29.8ml	34.2ml	37.0ml	40.3ml	44.2ml
Final weight of the compressed tablet	444mg	438mg	438mg	440mg	434mg

*CLINICAL STUDY:*

*A) - Study protocol.*

75 The disintegration of the compressed tablets of Examples 3, 4, 5, 6 and 7 was tested, in man. The compressed tablets contain barium sulphate. They are thus visible on a radiographic control.

With dinner (19.30 hours) and the next day with 80 breakfast (07.00-08.00 hours) a compressed tablet was given to the patient, that is 2 in all.

A radiograph of the abdomen was taken between 14.00 hours and 15.00 hours, that is about 19 and 7

hours respectively after the oral dose.

85 It was possible to observe:

1 - *The state of disintegration* of the compressed tablets which is expressed in the following manner:  
- *whole* for a compressed tablet of preserved outline and density,

90 - *eaten away* for a compressed tablet slightly changed on its density and outline,  
- *emptied* for a compressed tablet of which only the still-locatable shell is visible and  
- *disintegrated* for a non-visible compressed tablet.

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Since none of the patients had motor diarrhoea, the non-visible compressed tablets were in reality disintegrated and not removed in the stools.

2. – *The location of the compressed tablets* defines the organ in which they are visible : three were located in the stomach and several in the small or in the large intestine.

**B) – Results.**

These are detailed in the summary of observations

10 appearing hereinafter.

The following *conclusions* can be drawn:

- a) The compressed tablets given the day before in the evening, that is to say 19 hours before the radiograph are all disintegrated:
- 15 b) the compressed tablets which are in the small intestine are all whole;
- c) the compressed tablets which are seen in the colon are rarely whole.

**OBSERVATIONS**

*Compressed tablets of Example 3*

**FIRST COMPRESSED TABLET**

Condition and location

ADD ... DISINTEGRATED  
FRE ... DISINTEGRATED

DEL ... DISINTEGRATED  
COU ... DISINTEGRATED  
KUN ... DISINTEGRATED  
MAS ... DISINTEGRATED  
KUL ... DISINTEGRATED  
SAR ... DISINTEGRATED  
BRU ... DISINTEGRATED

**SECOND COMPRESSED TABLET**

Condition and location

WHOLE. CAECUM  
WHOLE. RIGHT CORNER OF  
THE COLON  
DISINTEGRATED  
DISINTEGRATED  
DISINTEGRATED  
DISINTEGRATED  
DISINTEGRATED  
WHOLE. STOMACH  
WHOLE. RIGHT CORNER OF  
THE COLON

*Compressed tablets of Example 4*

**FIRST COMPRESSED TABLET**

Condition and location

KER ... DISINTEGRATED  
GOD ... DISINTEGRATED  
HUR ... DISINTEGRATED  
RYL ... DISINTEGRATED  
DIR ... DISINTEGRATED  
ROY ... DISINTEGRATED  
BOU ... DISINTEGRATED  
NGU ... DISINTEGRATED  
FEH ... EMPTIED. CAECUM

**SECOND COMPRESSED TABLET**

Condition and location

DISINTEGRATED  
DISINTEGRATED  
DISINTEGRATED  
DISINTEGRATED  
WHOLE. SMALL INTESTINE  
WHOLE. SMALL INTESTINE  
WHOLE. SMALL INTESTINE  
DISINTEGRATED  
WHOLE. SMALL INTESTINE

*Compressed tablets of Example 5*

**FIRST COMPRESSED TABLET**

Condition and location

CAM ... DISINTEGRATED  
LAM ... DISINTEGRATED  
KOC ... DISINTEGRATED

LOU ... DISINTEGRATED  
SAL ... DISINTEGRATED

LAS ... DISINTEGRATED

PON ... DISINTEGRATED

**SECOND COMPRESSED TABLET**

Condition and location

DISINTEGRATED  
DISINTEGRATED  
WHOLE. RIGHT CORNER OF  
THE COLON  
WHOLE. CAECUM  
WHOLE. RIGHT CORNER OF  
THE COLON  
WHOLE. RIGHT CORNER OF  
THE COLON  
DISINTEGRATED

*Compressed tablets of Example 6*

**FIRST COMPRESSED TABLET**

Condition and location

DUR ... CAECUM. EATEN AWAY  
CHA ... DISINTEGRATED  
DEL ... DISINTEGRATED  
AIR ... DISINTEGRATED  
DER ... EMPTIED. RIGHT CORNER  
OF THE COLON  
HUR ... DISINTEGRATED  
BEN ... EMPTIED. RIGHT CORNER

**SECOND COMPRESSED TABLET**

Condition and location

WHOLE. SMALL INTESTINE  
WHOLE. SMALL INTESTINE  
WHOLE. SMALL INTESTINE  
DISINTEGRATED  
WHOLE. SMALL INTESTINE  
DISINTEGRATED  
WHOLE. SMALL INTESTINE

*Compressed tablets of Example 7*  
**FIRST COMPRESSED TABLET**

Condition and location

MER . . . DISINTEGRATED  
 FRA . . . DISINTEGRATED  
 BER . . . DISINTEGRATED  
 REM . . . DISINTEGRATED  
 GON . . . DISINTEGRATED  
 JOE . . . DISINTEGRATED  
 NEP . . . EMPTIED. RIGHT CORNER  
 OF THE COLON  
 LEG . . . DISINTEGRATED  
 GAU . . . DISINTEGRATED

**SECOND COMPRESSED TABLET**

Condition and location

EATEN AWAY. SMALL INTESTINE  
 DISINTEGRATED  
 WHOLE. SMALL INTESTINE  
 WHOLE. STOMACH  
 WHOLE. RIGHT CORNER  
 WHOLE. STOMACH  
 WHOLE. CAECUM  
 DISINTEGRATED  
 DISINTEGRATED

**CLAIMS**

1. Compressed tablets adapted for disintegration in the colon comprising a centre containing the active principle, the said centre being covered successively:
  - a) with a first coating layer comprised of a film-forming product which does not deteriorate in neutral or alkaline medium and of microcrystalline cellulose and
  - b) with a second coating layer comprised of an enteric coating agent.
2. Compressed tablets as claimed in claim 1 wherein at least one of the coating layers additionally contains one or more plasticizers.
3. Compressed tablets as claimed in claim 1 or claim 2 wherein the first coating has a mass of from 0.5% to 10% of that of the centre, and the first coating contains from 30% to 80% by mass of microcrystalline cellulose.
4. Compressed tablets as claimed in any preceding claim wherein the film-forming product is ethyl cellulose.
5. Compressed tablets as claimed in any preceding claim wherein the enteric coating agent is cellulose acetate.
6. Compressed tablets as claimed in any preceding claim wherein the enteric coating agent has a mass of from 2% to 10% of that of the centre.
7. Compressed tablets as claimed in any preceding claim wherein the plasticisers are selected from diethyl phthalate, dibutyl phthalate and propylene glycol.
8. Compressed tablets as claimed in claim 1 substantially as herein described.
9. Compressed tablets substantially as herein described in any one of Examples 1 to 7.
10. A process for preparing compressed tablets as claimed in claim 1 which comprises coating centres containing the active principle by spraying thereon a solution of a film-forming product which does not deteriorate in neutral or alkaline medium and of microcrystalline cellulose in a solvent; drying the said coated centres; and then spraying a solution of an enteric coating agent in a solvent onto the dried coated centres and drying.
11. A process as claimed in claim 10 wherein the coating is carried out in a tumbler.
12. A process as claimed in claim 10 or claim 11 wherein the solution of the film-forming product and cellulose and/or the solution of the enteric coating agent additionally contain one or more plasticisers.

13. A process for the preparation of compressed tablets as claimed in claim 1 substantially as herein described.

14. A process for the preparation of compressed tablets as claimed in claim 1 substantially as herein described in any one of Examples 1 to 7.

15. Each and every novel method, process, composition and product herein disclosed.

Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd.,  
 Berwick-upon-Tweed, 1981.  
 Published at the Patent Office, 25 Southampton Buildings, London, WC2A 1AY,  
 from which copies may be obtained.

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